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## (54) ICE CREAM

(71) We, UNILEVER LIMITED, a company organised under the laws of Great Britain, of Unilever House, Blackfriars, London, E.C.4, England, do hereby declare the invention for which we pray that a patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to stabilised ice cream.

The way in which ice cream behaves on exposure to normal room temperature is important for the consumer. If a product behaves too atypically, for instance if a product melts too rapidly or separates into a fatty phase and a clear aqueous phase on melting, then the product will be unacceptable. In the ice cream industry methods have been developed for measuring such properties, for instance meltdown and stand-up. These are described later.

It is known that such properties can be affected by the use of stabiliser, often called thickeners. A problem that arises is that the stabilisers deleteriously affect the feel of the ice cream in the mouth; a cloying, gummy or even greasy feel can occur. This problem is acute in ice creams that require more than usual stabilisation. What is desired is a stabiliser system that is good or at least adequate with respect to all aspects of stability. This is difficult to achieve for normal ice creams and particularly so for ice creams that require more than usual stabilisation.

A stabiliser system has now been found that is surprisingly effective in stabilising ice cream without giving an unacceptable mouth feel. The stabiliser system is agar-agar in combination with a galactomannan gum. Examples of galactomannan gums are guar gum, locust bean gum and tara gum. Locust bean gum or tara gum, particularly locust bean gum, is preferred.

The invention therefore provides ice cream stabilised with a stabiliser mixture comprising agar-agar and at least one galactomannan gum.

Chapter 6 of the standard text-book, Ice Cream, by Arbuckle, Second Edition, The Avi Publishing Company, 1972 contains a survey of possible stabilisers for use in ice cream. Two of these are agar-agar and locust bean gum (carob gum). On agar-agar Arbuckle states that it has been recommended for use in combination with gums for gelation in sherbets and ices but continues: "Although it swells and absorbs large quantities of water and thus prevents coarseness in the finished product, it is not easily dispersed in the mix and tends to produce a crumbly body. It is also high in cost." On locust bean gum Arbuckle states that it "is an ingredient of stabiliser sold mainly for use in sherbets and ices. Its principal advantage in these products is that it inhibits overrun. Since it has a tendency to cause curdling of the milk proteins, its use in ice cream is limited, and heating to temperatures above 100° F should be avoided." It has now surprisingly been found that these two stabilisers in combination are significantly better stabilisers than would be expected from the above or from study of each separately.

As emphasised above the stabiliser system is particularly useful in ice creams that require more than usual stabilisation.

Conventional ice cream is prepared by a process involving freezing and then hardening to temperatures in the order of −20° C to −40° C. The product characteristics required for a conventional ice cream will depend on the personal tastes of the consumer and ice creams are formulated to meet a variety of such tastes; the formulation of any one conventional ice cream will depend on the tastes of the consumers concerned.

One characteristic of ice cream that we have recognised to be important is the log C, as defined later, of the ice cream. In the UK from our measurements conventional ice creams have a log Cs at −20° C, after hardening at the lowest of 2.9 (and at the highest of 3.7) but usually in the range of 2.9 to 3.3. (A technique for measuring C and hence log C is described later in the specification.) C values will be taken after hardening conventionally as indicated and as for instance

described in the standard text-books.

It has been found that an ice cream spoonable at $-20°$ C has major advantages over conventional ice cream in particular in that it is more readily spoonable at deep-freeze temperatures and so can be served more readily direct from the deep freeze. A correlation has been found to exist between spoonability and log C and it has been found that, for an ice cream to be spoonable, its log C at $-20°$ C should be less than that of conventional ice cream, i.e. less than 2.9 and preferably less than 2.8, particularly preferably less than 2.5.

This invention, by which hardened ice cream with a log C at $-20°$ C of less than 2.9 is provided is described and claimed in our copending application 13288/74 (Serial No. 1,508,437) (cognate of 13288/74, 30165/74 and 2978/75).

Conveniently such an ice cream can be achieved by addition of freezing-point depressants to the formulation of a conventional ice cream, at the expense of water, in amounts sufficient to lower the log C at $-20°$ C by between 0.25 and 1, preferably by 0.4 to 0.75. It should further be noted that the log C at $-20°$ C of an ice cream according to the invention should preferably not be less than 2.3.

A particularly surprising aspect of the invention is the achievement, by use of the claimed stabilizer mixture, of an ice cream formulated to have a log C at $-20$ C of less than 2.9 but with comparable serving and eating characteristics at normal eating temperatures to ice cream similarly formulated except that its content of freezing-point depressants is such that its log C at $-20$ C is between 0.25 and 1 higher, preferably 0.4 to 0.75 higher, than that of the ice cream formulated to have a log C at $-20$C of less than 2.9.

In general more freezing-point depressants will be used than in conventional ice creams. Preferred freezing-point depressants are monosaccharides and low molecular-weight alcohols (i.e. molecular weights less than 100), preferably polyalcohols and in particular glycerol and sorbitol. The freezing-point depressant or depressants should preferably be such that the product has the desired (by the consumer) sweetness as well as the desired spoonability at $-20°$ C.

Such ice creams are examples of ice creams that benefit from careful stabilisation. Our copending application referred to mentions and claims the stabilisation with locust bean gum, particularly with other stabilisers. A particularly important aspect of the present invention is the use of a stabiliser mixture comprising agar-agar and at least one galactomannan gum to stabilize such ice creams.

Galactomannan gums and agar-agar are well-known materials and are described for instance by M Glicksman in "Gum Technology in the Food Industry", Academic Press, 1969.

The amount of agar-agar should, in an ice cream, preferably be from 0.05% to 0.15% by weight; the amount of galactomannan gum should preferably be from 0.05% to 0.20% and the weight ratio of agar-agar to galactomannan gum should preferably be in the range 1:1 to 1:3. The amounts and ratio of the two stabilisers depends to some extent on other ingredients present but the above is a useful general rule and in any case can be determined readily by experiment.

Of course preferably neither component should be at or near its lower limit in any one stabiliser system. The total amount of these stabilisers is preferably 0.15% or above.

The stabiliser system, preferably also contains a maltodextrin of DE (dextrose equivalent) less than 20, preferably less than 15. The maltodextrin must be soluble. The lower limit for DE at which maltodextrins become insoluble depends particularly on the other ingredients in an ice cream mix but whether a given maltodextrin is soluble in any such mix can be determined readily by experiment and in particular by noting whether it leads to the desired effect.

It is believed that the maltodextrin excludes water from protein, such as casein, present in ice cream and causes the protein to precipitate, particularly on heating, for example, during pasteurisation. The precipitated protein destabilises the fat droplets in the ice cream by causing them to clump and finally to coalesce which affects the stability of the ice cream. The amount of low DE maltodextrin should preferably be in the range 0.5—3%.

Maltodextrins can for example be obtained by the mild hydrolysis of starch. Enzymatic hydrolysis, optionally under acidic conditions, of the starch can be used; the conditions are so mild that negligible repolymerisation occurs. This is in contrast to dextrins which typically are made from starch by hydrolysis and repolymerisation using high temperature and pressure.

In this specification, including the claims, percentages are by weight and in particular are by weight of ice cream except where the context requires otherwise.

Other than in the use of sufficient freezing point depressant for the preferred aspect of the invention and in the use of a stabilising system comprising particular components no especial insight is required in the formulation or processing of ice creams according to the invention. Details of conventional formulations and processing conditions for ice cream can be found in the usual trade publications and text books. Particularly useful in this respect is Arbuckle, "Ice Cream", 1972 (2nd Edition), AVI Publishing Corp., Westpoint, Conn.

The invention will now be illustrated further by the following examples.

The properties of the stabiliser system are most surprising when compared with the properties of the separate components. This is illustrated in the examples.

EXAMPLE 1.

An ice cream was prepared by conventional processing techniques to the following formulation:

| Ingredient | % by weight |
|---|---|
| Skimmed Milk Powder | 12.0 |
| Sugar | 10.0 |
| Sorbitol | 3.0 |
| Dextrose (monohydrate) | 3.0 |
| Butter | 12.0 |
| Mono/Di-glyceride emulsifier | 0.3 |
| Agar-agar 434* | 0.1 |
| Locust Bean Gum | 0.15 |
| 17 DE Maltodextrin | 2.0 |
| Water | to 100.0 |

* Sold by Thomas Douche Ltd., London and found to have a positive contribution, as discussed above, of 8°.

An ice cream was obtained that was spoonable at domestic deep freeze temperature and yet had excellent stand-up, melt-down, taste and texture at normal eating temperature.

EXAMPLES 2 to 7
and COMPARISONS A to D

Ice cream mixes were prepared conventionally to the following formulation. Further details are given in the following Table which also shows results obtained with ice cream prepared conventionally from the mixtures. A standard UK non-dairy ice cream differs from this formulation in containing no glycerol and 1.4% by weight more sugar. 3% glycerol is roughly equivalent in sweetness to 1.5% sugar.

| | |
|---|---|
| Spray dried milk powder | 9.5 |
| Sugar | 13.5 |
| Glucose syrup | 1.7 |
| Palm oil | 9.5 |
| Monoglyceride from palm oil | 0.5 |
| Glycerol | 3.0 |
| Salt | 0.05 |
| Flavour and colour | 0.1 |
| Stabilisers | Table |
| Water | to 100 |

The log C values at −20°C of the Examples were in the range 2.5 and 2.9. The log C of the standard ice cream mentioned above was in the range 3.2 to 3.3.

| Example or Comparison | Stabiliser % by weight | | | Min Viscosity (cps) | Overrun % | Meltdown at 15°C | | Shape Retention | Stability Cycling |
|---|---|---|---|---|---|---|---|---|---|
| | LBG | Agar-Agar | Low–DE Maltodextrin | | | 1st 10 ml (mins) | Rate (mls/hr) | | |
| A | | 0.1 | | 42 | 64 | 100 | 28 | Poor | Poor |
| B | 0.175 | | | 44 | 85 | 80 | 26 | Poor | Poor |
| C | | | 2(17–DE) | 17 | 52 | 50 | 136 | Bad | Bad |
| D | 0.175 | | 2(17–DE) | 58 | 110 | 110 | 13 | Fair | Poor |
| 1 | 0.175 | 0.1 | 2(17–DE) | 79 | 115 | 126 | 8 | Good | Fair |
| 2 | 0.175 | 0.1 | 2(17–DE) | 79 | 115 | 126 | 9 | Good | |
| 3 | 0.175 | 0.05 | 2(17–DE) | 49 | 121 | 125 | 9 | Fair | Fair |
| 4 | 0.1 | 0.1 | 2(17–DE) | 44 | 123 | 115 | 9 | Fair. | Fair |
| 5 | 0.175 | 0.1 | 1(17–DE) | 66 | 118 | 127 | 7 | Good | |
| 6 | 0.175 | 0.1 | 2(12–DE) | 57 | 118 | 135 | 9 | Fair | Good |
| 7 | 0.175 | 0.15 | 2(17–DE) | 59 | 105 | 140 | 8 | Good | Fair |

* The agar-agar is a normal agar-agar, e.g. one from a Gelidium seaweed.

## Test Methods

*Melt-Down Test and Shape Retention*

A rectangular block of ice cream of length 13.6 cm, height 4.0 cm and width about 8.8 cm which has been stored at −20° C is placed on a wire gauze (10 wires per inch) in an atmosphere maintained at 15° C. Arrangments are made for collection of the liquid drained from the gauze. The time for the collection of the first 10 ml of liquid is noted. The volume of liquid collected in each subsequent 10 minute period is measured and the slope of the graph obtained by plotting volume collected against time is taken as the meltdown (mls/hr). After 4 hours thawing photographs of the residue of the brick are taken, and the degree of shape retention assessed as bad, poor, fair, good or very good.

*Stability to Temperature Cycling*

This was carried out on an approximately cuboid ½ gallon block of ice cream in a plastic container. After storage in a deep-freez it was transferred to ambient (20° C) for 1½ hours and then to a refrigerator at −10° C. Next day the block was subjected to further temperature shock cycling by being taken out of the refrigerator and ieft at ambient for ½ hour. This (each day ½ hour at ambient) was repeated to a total of six times and then the block was returned to the deep-freeze for assessment the next day. The total test took, allowing for a weekend, not more than ten days. Product stability was assessed as follows:

Bad: total breakdown
Poor: >20% of product converted to serum
Fair: 5—20% of product converted to serum
Good: <5% of product converted to serum

*C and Log C*

To determine C and hence log C the following method is used:

*Principle*

The hardness of ice cream is measured by allowing a standard cone to penetrate a sample for 15 seconds using a cone penetrometer. The C-value can be calculated from the penetration depth.

*Apparatus:*

*Ebonite cone*

With an apex angle of 40° and the tip blunted by a few strokes on fine abrasive paper to give a flat 0.3 ± 0.03 mm in diameter. Total weight of cone and sliding penetrometer shaft 80 ±0.3 g.; also additional weights of 80 ±0.3 g.

*Penetrometer*

This should have a scale calibrated in 0.1 mm., and be fitted with a lens. The penetrometer made by Sommer and Runge, Berlin, is recommended, particularly for static use. The Hutchinson instrument can also be used; it requires no electricity supply, but must be modified for satisfactory operation. The accuracy of penetrometer timing mechanisms must be checked regularly. The use of a ×3 magnification lens of about 6—8 cm. diameter fitted to the penetrometer facilitates the setting of the cone tip on the sample surface, and an unfocused light limited to the equivalent of a 1-watt bulb at a distance of about 5 cm. (to avoid heating the sample surface) is also advantageous.

*Temperature probe*

The temperature probe should read to within 0.1° C and have a stem about 1 mm. in diameter and about 4 cm. long. Its accuracy should be checked regularly in baths of known temperatures.

*Tempering facilities*

(a) Room controlled at required temperature ± 1° C;
(b) Constant-temperature cabinets, tolerance ±0.2° C.
The forced-draught constant-temperature cabinets supplied by Zero N.V. Rotterdam are satisfactory.

*Process:*

*Sampling*

Samples should be convenient size and preferably with smooth surfaces to increase accuracy.

*Tempering*

2 Days at whatever temperature is required e.g. −20° C. Measure temperature accurately before penetration.

*Measurement*

Where possible, penetrations are made in the temperature-controlled room, and should be completed within two minutes of removing the sample from the constant-temperature cabinet.

1. Insert the temperature probe as near horizontally as possible at a few mm. below the sample surface, read and note the sample temperature after 30 seconds. (Reject any samples differing by more than 0.5° C from the nominal test temperature.)
2. Place the samples on the levelled penetrometer table.
3. Set the cone tip accurately on the sample surface, using a lens and, if necessary, oblique lighting.
4. Release the arresting device and allow the cone to penetrate the sample for 15 seconds.
5. Read and note the penetration depth.
6. Should the penetration depth be less than 72 × 0.1 mm. (equivalent to a C-value of more than 500g./cm.²) the measurement should be repeated with the cone weight increased by 80 g. Further 80 g. weights may be added as necessary to ensure adequate penetration of the sample and the C-value scale reading corrected accordingly.
7. Penetration measurements should not be made within 2 cm. of the sample edge nor within 2.5 cm. of each other. Determinations in which air bubbles, cracks, etc. interfere should be rejected.

*Calculation of C-values*

The C-value can be calculated from the penetration depth using the formula:

$$C = \frac{K \times F}{p^{1.6}}$$

where

C = Yield value or C-value (g./cm.²)
F = Total weight of cone and sliding stem (g.)*
P = Penetration depth (0.1 mm.)
K = Factor depending on cone angle:

| Cone angle° | K value |
|---|---|
| 30 | 9670 |
| 40 | 5840 |
| 60 | 2815 |
| 90 | 1040 |

* Depending on the likely softness of the product, the cone weight should be adjusted, eg

| | |
|---|---|
| at $-10°$ C | use 80 gm |
| at $-15°$ C | use 160 gm |
| at $-20°$ C | use 240 gm |

ie it depends on temperature of measurement.

C values will usually be taken after hardening conventionally, as for instance described on page 4, lines 18 to 20, and in the standard text-books.

It should be noted that an ice cream based on vegetable fat according to the invention preferably has a melt-down, determined as described above, of less than 25 ml/hr and particularly preferably of between 5 and 20 ml/hr.

WHAT WE CLAIM IS:—

1. Ice cream stabilised with a stabiliser mixture comprising agar-agar and at least one galactomannan gum.

2. Ice cream as claimed in Claim 1 in which the amount of agar-agar is at least 0.05% by weight of the ice cream.

3. Ice cream as claimed in Claim 2 in which the amount is not more than 0.15%.

4. Ice cream as claimed in any one preceding claim in which the amount of galactomannan gum or gums is at least 0.05% by weight of the ice cream.

5. Ice cream as claimed in Claim 4 in which the amount of galactomannan gum or gums is not more than 0.2% by weight of the ice cream.

6. Ice cream as claimed in any one preceding claim in which the total amount of agar-agar and galactomannan gum or gums is at least 0.15% by weight of the ice cream.

7. Ice cream as claimed in any one preceding claim characterised in that the weight ratio of agar-agar to galactomannan gum or gums is in the range 1:1 to 1:3.

8. Ice cream as claimed in any one preceding claim which has a log C as herein defined of less than 2.9 at $-20°$ C.

9. Ice cream as claimed in Claim 8 which has a log C less than 2.8 at $-20°$ C.

10. Ice cream as claimed in Claim 9 which has a log C less than 2.5 at $-20°$ C.

11. Ice cream as claimed in any one of Claims 8 to 10 which has a log C at $-20°$ C as herein defined of not below 2.3.

12. Ice cream as claimed in any one of Claims 8 to 11 with comparable serving and eating characteristics at normal eating temperatures to ice cream similarly formulated except that its content of freezing-point depressants is such that its log C at $-20°$ C is between 0.25 and 1 higher.

13. Ice cream as claimed in Claim 12 with comparable serving and eating characteristics at normal eating temperatures to ice cream similarly formulated except that its content of freezing-point depressants is such that its log C at $-20°$ C is between 0.4 to 0.75 higher.

14. Ice cream as claimed in any one preceding claim containing glycerol or sorbitol as a freezing-point depressant.

15. Ice cream as claimed in any one preceding claim based on vegetable fat and with a melt-down as herein defined of less than 25 ml/hr at 15° C.

16. Ice cream as claimed in Claim 15 in which the melt-down is between 5 and 20 ml/hr at 15° C.

17. Ice cream as claimed in any one preceding claim in which the galactomannan gum is locust bean gum or tara gum.

18. Ice cream as claimed in Claim 18 in which the galactomannan gum is locust bean gum.

19. An ice cream as claimed in Claim 8 substantially as described and with particular reference to Example 1.

20. Ice cream as claimed in Claim 8 substantially as described and with particular reference to any one of Examples 2 to 7.

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